BACKGROUND OF THE INVENTION

1. FIELD OF THE INVENTION:

The present invention relates to an imaging device capable of imaging objects in a maximum of the omniazimuthal angle of 360 degrees and used in the field of visual systems such as, for example, surveillance cameras.

2. DESCRIPTION OF THE RELATED ART:

Recently in the field of visual systems such as, for example, surveillance cameras, various attempts have been made to allow a camera to perform monitoring operations conventionally conducted by the human eye, by combining the camera with a computer.

A generally used camera, which has a limited viewing angle, is not suitable for such applications. Therefore, cameras using fish-eye lenses or other wide-angle lenses have been developed. For example, in the field of movable robots, the use of convex mirrors having a shape of solid of revolution (such as conical mirrors), spherical mirrors or the like, have been actively studied. (Hereinafter, such convex mirrors

will be referred to as "convex rotatable mirrors".) According to systems studied in this field, an optical image of a viewing angle of 360 degrees is taken by a convex rotatable mirror, then the optical image is converted into a video image, and the video image is further converted into a desired image by a computer.

Figure 9 is a projection figure of an imaging device **90** using a conventional convex rotational mirror. The imaging device **90** includes a convex rotational mirror unit **91**. The convex rotational mirror unit **91** includes a generally disc-shaped base **92** and a convex rotational mirror **93** provided on a surface of the base **92**. The imaging device **90** further includes a generally cylindrical optical member **94**. The optical member **94** is open toward the convex rotational mirror unit **91** and covers the surface of the base **92** and the convex rotational mirror **93**. The optical member **94** holds the convex rotational mirror unit **91** and is formed of a light-transmissive material. An inner circumferential surface of the optical member **94** and the convex rotational mirror **93** interpose a hollow space therebetween. The optical member **94** has a thickness which is sufficiently thin to allow light which is incident on an outer circumferential

surface of the optical member **94** to be transmitted through the optical member **94**, so that it is proximately parallel to light which is directed toward the convex rotational mirror **93** from the inner circumferential surface of the optical member **94**.

A generally cylindrical imaging mechanism **98** is attached at the opposite side to the convex rotational mirror unit **91**, with the optical member **94** interposed therebetween. The imaging mechanism **98** includes a lens **99** facing an opening of the optical member **94**, which is formed on the opposite side to the convex rotational mirror unit **91**, and an imaging section **90** provided on the opposite side to the optical member **94**, with the lens **99** interposed therebetween. The imaging section **90** is connected to a signal processing section **88** provided for adjusting distortion of an image taken by the imaging mechanism **98**.

As described above, the light-transmissive optical member **94** is used for holding the convex rotational mirror unit **91**, and thus a separate holding member is not provided. The reason is that if a separate holding member is provided for holding the convex

rotational mirror unit **91**, an image of the holding member itself would be taken and so would be a part of an image taken by the imaging mechanism **98**.

The imaging device **90** having the above-described structure operates as follows.

Light **71** is incident on the outer circumferential surface of the light-transmissive optical member **94** and is transmitted through the optical member **94**. While being transmitted through the optical member **94**, the incident light **71** is refracted twice (not shown) so as to become light **72**. The light **72** is directed from the inner circumferential surface of the optical member **94** toward the convex rotational mirror **93** through the hollow space between the optical member **94** and the convex rotational mirror **93**. Then, the light **72** is reflected by the convex rotational mirror **93** and is directed toward the imaging mechanism **98** as reflected light **81**. The reflected light **81** is transmitted through the lens **99** of the imaging mechanism **98** and is incident on the imaging section **90**. The imaging section **90** converts the reflected light **81** into an image signal representing an image and outputs the image signal to the signal processing section **88**. The

signal processing section **88** processes the received image signal so as to adjust the distortion of the image.

Light **73**, which is incident on the outer circumferential surface of the light-transmissive optical member **94** from the opposite direction to the light **71**, is transmitted through the optical member **94**. While being transmitted through the optical member **94**, the incident light **73** is refracted twice (not shown) so as to become light **74**. The light **74** is directed from a portion of the inner circumferential surface of the optical member **94** toward another portion of the inner circumferential surface of the optical member **94** opposite the portion from which the light **74** is directed. The light **74** is reflected by the inner circumferential surface of the optical member **94** and is directed toward the convex rotational mirror **93** as reflected light **82**. Thus, the reflected light **82** is superimposed on the light **72** directed toward the convex rotational mirror **93**.

Normally, an image produced by the imaging device **90** representing the reflected light **81** reflected by the convex rotational mirror **93** is supposed to be based only on the incident light **71**. When the reflected light **82**

is superimposed on the light **72**, however, an image produced by the imaging device **90** undesirably includes both an image based on the incident light **71** and another image based on the incident light **73** in a superimposed state.

Japanese Patent Publication (Kokai) No. heisei 11-174603 discloses an imaging device having a structure for solving this problem. In this publication, attention is paid to the fact that incident light reflected by an inner surface of an optical member and directed to a convex rotational mirror crosses the rotation axis of the convex rotational mirror. A rod-like member for shielding the incident light directed to the inner surface of the optical member is provided along the rotation axis of the convex rotational mirror. Thus, the incident light directed to the inner surface of the optical member is prevented from being reflected by the inner surface and thus prevented from being directed toward the convex rotational mirror.

However, the technology described in the above-mentioned publication has the following problems.

Since the rod-like member is required to be additionally provided, the structure of the imaging device is complicated and the number of production steps of the imaging device is increased.

Since the optical member is hollow, a structure is required to mechanically support the rod-like member provided along the rotation axis of the convex rotational mirror so that the rod-like member is not destroyed when the imaging device is actually used.

SUMMARY OF THE INVENTION

According to one aspect of the invention, an imaging device includes a convex mirror for reflecting first incident light representing an object, the convex mirror having a shape of solid of revolution; an imaging mechanism for taking a reflected image represented by light reflected in the convex mirror; and an optical member for guiding the first incident light toward the convex mirror and guiding the reflected light toward the imaging mechanism, the optical member having an attenuation section for attenuating second incident light which is incident on an outer circumferential surface of

the optical member in an opposite direction to the first incident light, passes through the optical member, is reflected by an inner circumferential surface of the optical member so as to be directed toward the convex rotational mirror, and is superimposed on the first incident light.

In one embodiment of the invention, the attenuation section is a hole formed in the optical member, and the hole contains an air layer therein having a different light transmittance from that of the optical member so that the second incident light is attenuated by crossing the hole.

In one embodiment of the invention, the hole is shaped so as not to obstruct a viewing angle provided by the convex rotational mirror.

In one embodiment of the invention, the hole is shaped as a body of revolution centered around a rotation axis of the convex rotational mirror.

In one embodiment of the invention, the hole is cylindrical.

In one embodiment of the invention, the hole is conical.

In one embodiment of the invention, the hole has a frosted surface for attenuating the second incident light.

In one embodiment of the invention, the imaging device further includes an electric wire for supplying electric power and a signal to the imaging mechanism, the electric wire passing through the hole and connected to the imaging mechanism.

In one embodiment of the invention, the hole is tapped for attaching the imaging device to an external member.

According to another aspect of the invention, an imaging device includes a convex mirror for reflecting first incident light representing an object, the convex mirror having a shape of solid of revolution; an imaging mechanism for taking a reflected image represented by light reflected in the convex mirror; and an optical

member for guiding the first incident light toward the convex mirror and guiding the reflected light toward the imaging mechanism, the optical member having a light-shielding section for shielding second incident light which is incident on an outer circumferential surface of the optical member in an opposite direction to the first incident light and passes through the optical member toward an inner circumferential surface of the optical member.

In one embodiment of the invention, the light-shielding section is a hole formed in the optical member, and the imaging device further includes a light-shielding thin film for shielding the second incident light.

Hereinafter, the function of the present invention will be described.

According to the present invention, the optical member of the imaging device is not hollow, unlike a conventional imaging device, and is filled with a light-transmissive material such as, for example, a light-transmissive resin or glass. The optical member has a hole centered around the rotation axis of a convex

rotational mirror. The air layer contained in the hole has a different light transmittance from that of the optical member. Therefore, an image produced by the imaging device does not include another image based on the light reflected by an inner surface of the optical member. This provides a clear image based only on the necessary light. The size of the hole can be appropriately determined based on the shape of the convex rotational mirror, imaging conditions and the like.

The hole can have any shape, but preferably has a shape of a body of revolution such as, for example, a conical or cylindrical shape along the rotation axis of the convex rotational mirror. With such a shape, the influence of the light reflected by the inner surface of the optical member on the produced image is reduced, regardless of the direction in which light is incident on the optical member.

As described below in a second example of the present invention, a light-shielding thin film formed of a material absorbing or diffusely reflecting light can be provided on an inner surface of the hole by application or vapor deposition. The light-shielding thin film

absorbs or diffusely reflects the light, and thus attenuates or shields unnecessary light. As a result, a clear image based only on the necessary light is produced. The light-shielding thin film can be light-absorbing or light-reflecting, but a light-absorbing film is preferable in order to substantially completely avoid the influence of reflected light. A light-reflecting film can be produced in the same step as the thin film for forming the convex rotational mirror.

As described below in a third example of the present invention, the inner surface of the hole can be frosted. Such an inner surface absorbs or diffusely reflects the light, and thus attenuates or shields unnecessary light. As a result, a clear image based only on the necessary light is produced.

As described below in a fourth example of the present invention, an electric wire connected to an imaging mechanism is allowed to pass through the hole. In this way, the electric wire is prevented from being included in an image taken by the imaging device.

As described below in a fifth example of the

present invention, the hole can be tapped. This facilitates the assembly of the imaging device with an external member.

Thus, the invention described herein makes possible the advantages of providing (1) an imaging device for providing a clear image with a simple structure; and (2) an imaging device for providing a clear image without an increase in the number of production steps therefor.

These and other advantages of the present invention will become apparent to those skilled in the art upon reading and understanding the following detailed description with reference to the accompanying figures.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a projection figure illustrating a schematic structure of an imaging device according to a first example of the present invention;

Figure 2 is a cross-sectional view of the imaging device shown in Figure 1;

Figure 3 is a view provided to illustrate a preferable shape of a hole formed in an optical member of the imaging device shown in Figure 1;

Figure 4 is a projection figure illustrating a schematic structure of an imaging device according to a second example of the present invention;

Figure 5 is a cross-sectional view of the imaging device shown in Figure 4;

Figure 6 is a cross-sectional view illustrating a structure of an imaging device according to a third example of the present invention;

Figure 7 is a cross-sectional view illustrating a structure of an imaging device according to a fourth example of the present invention;

Figure 8 is a cross-sectional view illustrating a structure of an imaging device according to a fifth example of the present invention; and

Figure **9** is a projection figure illustrating a schematic structure of a conventional imaging device.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Hereinafter, the present invention will be described by way of illustrative examples with reference to the accompanying drawings.

(Example 1)

Figure **1** is a projection figure schematically illustrating a structure of an imaging device **100** according to a first example of the present invention. Figure **2** is a partial cross-sectional view of the imaging device **100** shown in Figure **1**.

The imaging device **100** includes a generally cylindrical optical member **4**. The optical member **4** is formed of a material which is light-transmissive and is unlikely to allow moisture to permeate therethrough, such as an acrylic resin, polycarbonate, light-transmissive glass or the like. A bottom surface of the optical member **4** has a recessed portion **5** (shaped as a body of revolution) and centered around the central axis of the optical member

4. In the example shown in Figure 1, the recessed portion 5 is hyperbolic.

A thin-film convex rotational mirror 3 is provided in close contact with the recessed portion 5. The convex rotational mirror 3 is also shaped as a body of revolution and centered around the central axis of the optical member 4. In the example shown in Figure 1, a surface of the convex rotational mirror 3 is hyperbolic. The recessed portion 5 and the surface of the convex rotational mirror 3 may be semi-spherical or conical.

The convex rotational mirror 3 is formed of a metal material such as, for example, aluminum or stainless steel. The convex rotational mirror 3 may alternatively be formed on the recessed portion 5 by vapor-depositing, sputtering or plating a material having a mirror surface effect such as, for example, aluminum, silver, platinum, a nickel-chromium alloy or gold. In this way, the convex rotational mirror 3 is formed to be in close contact with the recessed portion 5 of the optical member 4, unlike the conventional imaging device 90 described above with reference to Figure 9 including the hollow optical member 94.

A protective layer 19 for protecting the thin-film convex rotational mirror 3 is provided on the convex rotational mirror 3. The convex rotational mirror 3 and the protective layer 5 are covered with a disc-shaped lid 2.

The optical member 4 has a cylindrical hole 12 (shaped as a body of revolution) centered around the central axis of the optical member 4. The cylindrical hole 12 is open toward the recessed portion 5. Another bottom surface of the optical member 4 which is opposite to the bottom surface having the recessed portion 5 has a semi-spherical reflected light releasing face 7 centered around the central axis of the optical member 4.

A generally cylindrical imaging mechanism 8 is provided on the opposite side to the convex rotational mirror 3, with the optical member 4 interposed therebetween. The imaging mechanism 8 includes a lens 9 provided so as to face the reflected light releasing face 7 of the optical member 4. The lens 9 is located so that an optical axis thereof matches the rotation axis

of the optical member **4** and the convex rotational mirror **3**. Thus, the lens **9** converges light reflected by the convex rotational mirror **3**. An imaging section **10** is provided on the opposite side to the optical member **4**, with the lens **9** interposed therebetween. The imaging section **10** is formed of a CCD or the like. The imaging section **10** generates an image signal representing a reflected image based on the reflected light converged by the lens **9**, and outputs the image signal to a signal processing section (not shown). The signal processing section adjusts the distortion of the image signal which is output from the imaging section **10**.

The imaging device **100** having the above-described structure operates as follows.

Incident light **21** which is incident on an outer circumferential surface of the optical member **4** formed of a light-transmissive material is refracted by the outer circumferential surface so as to become light **22**. The light **22** passes through the optical member **4** and reaches the convex rotational mirror **3** which is in close-contact with the optical member **4**.

The light **22** incident on the convex rotational mirror **3** is reflected by the surface of the convex rotational mirror **3** so as to become reflected light **41**. The reflected light **41** passes through the reflected light releasing face **7** of the optical member **4** and is converged by the lens **9** in the imaging mechanism **8**. The imaging section **10** generates an image signal representing a reflected image based on the reflected light **41** converged by the lens **9**, and outputs the image signal to the signal processing section (not shown). The signal processing section adjusts the distortion of the image signal which is output from the imaging section **10**.

Incident light **23**, which is incident on the outer circumferential surface of the optical member **4** from the opposite direction to the incident light **21**, is refracted so as to become light **24**. The light **24** is incident on the cylindrical hole **12**. Then, the light **24** is partially reflected by a wall of the cylindrical hole **12**, and is partially refracted by the wall of the cylindrical hole **12** so as to become light **25**. The light **25** crosses the cylindrical hole **12** and is directed to a portion of the wall of the cylindrical hole **12** which is opposite to a portion of the wall on which the light **24** is incident.

The light 25 reaching the portion of the wall of the cylindrical hole 12 is partially reflected by the wall, and is partially refracted by the wall so as to become light 26. The light 26 exiting the cylindrical hole 12 is directed to the inner circumferential surface of the optical member 4 at a portion opposite to a portion of the outer circumferential surface on which the light 23 is incident.

Thus, the light 24 incident on the optical member 4 is attenuated by being reflected and refracted by the wall of the cylindrical hole 12, and therefore the intensity of the light 25 is lower than the intensity of the light 24. The light 25 is also attenuated by being reflected and refracted by the wall of the cylindrical hole 12, and therefore the intensity of the light 26 is lower still than the intensity of the light 25.

The light 26 incident on the inner circumferential surface of the optical member 4 is reflected by the inner circumferential surface and is superimposed on the light 22 directed toward the convex rotational mirror 23. The light 26 has been attenuated as a result of being reflected twice and refracted twice by the wall of the cylindrical

hole 12 and thus has a very low intensity. Therefore, the influence of the light 26 on the image provided by the imaging device 100 is negligible. Thus, an image represented only by the incident light 21 can be provided.

As described above, in the first example of the present invention, the cylindrical hole 12 formed in the optical member 4 attenuates the light, which is incident on the optical member 4 from the opposite direction to the incident light 21, passes through the optical member 4, is reflected by the inner circumferential surface of the optical member 4 to be directed toward the convex rotational mirror 3 and is superimposed on the light 22 also directed toward the convex rotational mirror 3. Therefore, it is not necessary to additionally provide a rod-like member for shielding the light and thus preventing the light from being superimposed on the light 22. The imaging device 100 can provide a clear image with a simple structure without an increase in the number of production steps therefor.

The reflected light releasing face 7 is semi-spherical. Therefore, the reflected light 41 reflected by the convex rotational mirror 3 passes through the

reflected light releasing face **7** in a direction normal to the reflected light releasing face **7**. The reflected light **41** is not refracted regardless of the material used to form the optical member **4**. For this reason, the optical system can be designed with ease.

Figure **3** is a view provided to illustrate a preferable shape of a cylindrical hole formed in an optical member. Identical elements previously discussed with respect to Figures **1** and **2** bear identical reference numerals therewith and the detailed descriptions thereof will be omitted.

Where the incident angle of light to be reflected by the convex rotational mirror **3** is in the range of angle **27** and angle **28**, the viewing angle provided by the convex rotational mirror **3** is in viewing angle range **A** and the light reflected by the convex rotational mirror **3** crosses area **B** and is directed toward the imaging mechanism **8**. Therefore, the reflected light crosses a space, obtained by rotating area **B** around a central axis **11** of the convex rotational mirror **3**. The reflected light does not cross a conical space obtained by rotating area **C**, inside area **B**, around the central axis **11** of the convex rotational

mirror **3**. In other words, the conical space obtained by rotating area **C** around the central axis **11** does not obstruct the viewing angle provided by the convex rotational mirror **3**.

In the case where the cylindrical hole **12** shown in Figure **2** has the shape of the conical space obtained by rotating area **C** around the central axis **11**, an image of an object represented by the incident light can be taken without obstructing the viewing angle provided by the convex rotational mirror **3** and the light incident on the optical member **4** and directed to an opposite portion of the optical member **4** can still be attenuated.

(Example 2)

Figure **4** is a projection figure schematically illustrating a structure of an imaging device **200** according to a second example of the present invention. Figure **5** is a partial cross-sectional view of the imaging device **200** shown in Figure **4**. Identical elements previously discussed with respect to Figures **1** and **2** bear identical reference numerals therewith and the detailed descriptions thereof will be omitted. In the imaging device **200** in the second example, unlike the imaging

device **100** in the first example, an optical member **4A** shaped as a body of revolution has a conical hole **12A** (shaped as a body of revolution), and a light-shielding thin film **13** is provided on an inner surface of the conical hole **12A**.

The conical hole **12A** is centered around the central axis of the optical member **4A** and is open toward the recessed portion **5**. The conical hole **12A** is formed so as not to obstruct the viewing angle provided by the convex rotational mirror **3**, as described above with reference to Figure 3. The light-shielding thin film **13** formed on an inner surface of the conical hole **12A** is preferably formed of a light-absorbing material. The light-shielding thin film **13** may alternatively be formed of a material diffusely reflecting light.

The imaging device **200** having the above-described structure operates as follows.

Incident light **21** which is incident on an outer circumferential surface of the optical member **4A** formed of a light-transmissive material is refracted by the outer circumferential surface so as to become light **22**. The

light **22** passes through the optical member **4A** and reaches the convex rotational mirror **3** which is in close-contact with the recessed portion **5** of the optical member **4A**.

The light **22** incident on the convex rotational mirror **3** is reflected by the surface of the convex rotational mirror **3** so as to become reflected light **41**. The reflected light **41** passes through the reflected light releasing face **7** of the optical member **4A** and is converged by the lens **9** in the imaging mechanism **8**. The imaging section **10** generates an image signal representing a reflected image based on the reflected light **41** converged by the lens **9**, and outputs the image signal to the signal processing section (not shown). The signal processing section adjusts the distortion of the image signal which is output from the imaging section **10**.

The incident light **23**, which is incident on the outer circumferential surface of the optical member **4A** from the opposite direction to the incident light **21**, is refracted so as to become light **24**. The light **24** is incident on the conical hole **12A**. The light-shielding thin film **13** provided on the inner surface of the conical hole **12A** absorbs the light **24**, thus preventing the light

24 from reaching a portion of the inner circumferential surface of the optical member **4A** opposite to a portion of the outer circumferential surface on which the light **23** is incident. Therefore, the light **24** is not superimposed on the light **22**.

As described above, in the second example of the present invention, the light-shielding thin film **13** shields the light **24** incident on the conical hole **12A** from the outer circumferential surface of the optical member **4**. Therefore, the light **24** is prevented from reaching the opposite portion of the outer circumferential surface and thus is not superimposed on the light **22**. As a result, the imaging device **200** can provide a clear image with a simple structure without an increase in the number of production steps therefor.

(Example 3)

Figure **6** is a cross-sectional view of an imaging device **300** according to a third example of the present invention. Identical elements previously discussed with respect to Figures **4** and **5** bear identical reference numerals therewith and the detailed descriptions thereof will be omitted. In the imaging device **300** in the third

example, unlike the imaging device **200** in the second example, an optical member **4B** has a conical hole **12B** (shaped as a body of revolution) and the conical hole **12B** has a frosted inner surface for attenuating light incident thereon.

The conical hole **12B** is centered around the central axis of the optical member **4B** and is open toward the recessed portion **5**.

The imaging device **300** having the above-described structure operates as follows.

Incident light **21** which is incident on an outer circumferential surface of the optical member **4B** formed of a light-transmissive material is refracted by the outer circumferential surface so as to become light **22**. The light **22** passes through the optical member **4B** and reaches the convex rotational mirror **3** which is in close-contact with the recessed portion **5** of the optical member **4B**.

The light **22** incident on the convex rotational mirror **3** is reflected by the surface of the convex rotational mirror **3** so as to become reflected light **41**.

The reflected light **41** passes through the reflected light releasing face **7** of the optical member **4B** and is converged by the lens **9** in the imaging mechanism **8** (Figure **1**). The imaging section **10** generates an image signal representing a reflected image based on the reflected light **41** converged by the lens **9**, and outputs the image signal to the signal processing section (not shown). The signal processing section adjusts the distortion of the image signal which is output from the imaging section **10**.

The incident light **23**, which is incident on the outer circumferential surface of the optical member **4B** from the opposite direction to the incident light **21**, is refracted so as to become light **24**. The light **24** is incident on the conical hole **12B**. The light **24** is diffusely reflected by the frosted inner surface of the conical hole **12B** and thus is attenuated. The light is further diffusely reflected and thus attenuated by a portion of the inner surface of the conical hole **12B** opposite to a portion of the inner surface on which the light is incident. Then, the light exits the conical hole **12B** and is reflected by a portion of the inner circumferential surface of the optical member **4B** opposite to a portion of the outer circumferential surface on which

the light **23** is incident. Although the light reflected by the inner circumferential surface is superimposed on the light **22**, the intensity_of the light is negligible.

As described above, in the third example of the present invention, the frosted inner surface of the conical hole **12B** attenuates the light incident thereon. Therefore, the intensity of the light reflected by the inner circumferential surface of the optical member **4B** and superimposed on the light **22** is negligible. As a result, the imaging device **300** can provide a clear image with a simple structure without an increase in the number of production steps therefor.

Since the conical hole **12B** has a frosted inner surface, the number of production steps of the imaging device can be reduced as compared to that of the imaging device **200** including the light-shielding thin film **13** on an inner surface of the conical hole **12A**.

(Example 4)

Figure **7** is a cross-sectional view of an imaging device **400** according to a fourth example of the present invention. Identical elements previously discussed with

respect to Figure **6** bear identical reference numerals therewith and the detailed descriptions thereof will be omitted. The imaging device **400** in the fourth example is different from the imaging device **300** in the third example in that the imaging device **400** includes an electric wire **14**.

The electric wire **14** is provided for supplying electric power and a signal to the imaging mechanism **8**. The electric wire **14** passes through the conical hole **12B** and is connected to the imaging mechanism **8**.

The imaging device **400** can be actually installed via (1) a member for supporting the imaging device **400** attached to one end (i.e., bottom) thereof, or (2) a member for supporting the imaging device **400** attached to another end (i.e., top) thereof. When the member is attached to the top of the imaging device **400**, for example, the electric wire **14** connected to the imaging mechanism **8** needs to be extended toward the top of the imaging device **400**.

In the fourth example, as shown in Figure **7**, the electric wire **14** is allowed to pass through the conical

hole 12B to be connected to the imaging mechanism 8. Since the conical hole 12B is advantageously formed so as not to obstruct the viewing angle provided by the convex rotational mirror 3, the electric wire 14 is not substantially contained in an image taken by the imaging device 400. By contrast, in the case where the electric wire 14 is passed to the outside of the optical member 4B, the electric wire 14 is undesirably included in an image taken by the imaging device 400.

When the member is attached to the bottom of the imaging device 400, the electric wire 14 connected to the imaging mechanism 8 can be extended to the bottom of the imaging device 8. The problem of the electric wire 14 being included in an image does not occur.

(Example 5)

Figure 8 is a cross-sectional view of an imaging device 500 according to a fifth example of the present invention. Identical elements previously discussed with respect to Figure 6 bear identical reference numerals therewith and the detailed descriptions thereof will be omitted.

The imaging device **500** includes an optical member **4B**, which has a conical hole **12B** (shaped as a body of revolution) centered around the central axis of the optical member **4B**. The conical hole **12B** is open toward the recessed portion **5**. The conical hole **12B** has a frosted inner surface. The imaging device **500** also includes a resin member **15**. The resin member **15** fills the conical hole **12B** and covers an end surface of the convex rotational mirror **3**, an end surface of the protective layer **19**, and a part of a surface of the protective layer **19**. The resin member **15** is tapped along the rotation axis of the convex rotational mirror **3**. The imaging device **500** further includes a rod-shaped member **17** for attaching the imaging device **500** to an external member. The rod-shaped member **17** is threaded at an end portion thereof so that a thread **18** is screwed into a thread **16**.

The imaging device **500** having the above-described structure operates as follows.

When the rod-shaped member **17** is rotated in a prescribed direction with respect to the optical member **4B** around the rotation axis thereof, the thread **18** of the rod-shaped member **17** is screwed into the thread **16** of the

resin member **15**, thus attaching the rod-shaped member **17** to the optical member **4B**. By attaching the rod-shaped member **17** to an external member (not shown) in this state, the imaging device **500** can be easily attached to the external member. Further, the thread **16**, which is formed in the resin member **15** filling the conical hole **12B**, can be formed to a deep position close to the center of the optical member **4B**. Therefore, the imaging device **500** can be attached to the external member with certainty.

As described above, in the fifth example of the present invention, the inner surface of the conical hole **12B** substantially has the thread **16** used for attaching the imaging device **500** to the external device. Therefore, the imaging device **500** can be attached to the external device with ease and certainty.

In the example shown in Figure **7**, the resin member **15** having the thread **16** is provided so as to fill the conical hole **12B**. The present invention is not limited to such a structure. A tapped resin may be provided so as to fill a cylindrical hole as shown in Figures **1** and **2**. In such a case, the thread can be formed to a position even deeper within the optical member. Thus, the imaging

device can be attached to the external device with a higher strength.

As described above, the present invention provides an imaging device for providing a clear image with a simple structure. The present invention also provides an imaging device for providing a clear image without an increase in the number of production steps therefor.

Various other modifications will be apparent to and can be readily made by those skilled in the art without departing from the scope and spirit of this invention. Accordingly, it is not intended that the scope of the claims appended hereto be limited to the description as set forth herein, but rather that the claims be broadly construed.